NVMe® Storage in the Real World: Google’s Path to NVMe Technology

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Software Architect, Google

Sponsored by NVM Express organization, the owner of NVMe specifications
Agenda

- Google’s Scale
- Google’s path to NVMe® technology
  - History of SSDs at Google
  - Benefits Google sees in NVMe technology
21 locations for owned and operated data centers

4 continents

**Americas**
- Berkeley County, South Carolina
- Council Bluffs, Iowa
- The Dalles, Oregon
- Douglas County, Georgia
- Henderson, Nevada
- Jackson County, Alabama
- Lenoir, North Carolina
- Loudoun County, Virginia
- Mayes County, Oklahoma
- Midlothian, Texas

**Europe**
- Montgomery County, Tennessee
- New Albany, Ohio
- Papillion, Nebraska
- Quilicura, Chile
- Dublin, Ireland
- Eemshaven, Netherlands
- Fredericia, Denmark
- Hamina, Finland
- St Ghislain, Belgium

**Asia**
- Changhua County, Taiwan
- Singapore
## Google SSDs over 11 years

<table>
<thead>
<tr>
<th></th>
<th><strong>Beginning: Simple PCIe SSD</strong></th>
<th><strong>Evolution of Internal SSD</strong></th>
<th><strong>3rd Party NVMe® SSD</strong></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Major use case: memory offload for Search. Think Google Instant Search.</td>
<td>Improvements were made to incrementally offload functionality to the drives</td>
<td>Benefit from industry optimizations &amp; mature ecosystem</td>
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<td>2</td>
<td>Host software stack did pretty much everything (FTL, mapping table)</td>
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NVMe® Technology Addresses Trends Google Cares About

Efficiency
- Efficient flash layout (FDP)
- Virtualization support

Limiting Complexity
- NAND Complexity abstracted by SSD vendor
- Transport and command set abstractions

Performance
- Efficient transport protocol
- Unleashes underlying scalability of NAND flash memory
Thank You
NVMe® Storage In the Real World

Ross Stenfort

Hardware Systems Engineer, Meta

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Agenda

- Background
- Where is NVMe® Technology Used?
- Benefits and Applications for NVMe® technology
Meta’s mission is to give people the power to build community and bring the world closer together.
Where does Hyperscale Use NVM Express®?
NVMe® Technology Benefits and Applications

❖ Benefits

- Performance
  - Scales with each PCIe Generation
  - Multi-tenant
  - Quality of service

- Management
  - Out of Band Access
  - Telemetry and health logs

❖ Applications

- Caching
- Database
- Boot drives
Thank You